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EGG-WEIGHT AS A CRITERION OF NUMERICAL PRODUCTION IN THE DOMESTIC FOWL[1]

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I

WHEN one surveys the field of literature dedicated to the subject of egg-production in the domestic fowl he may well be astonished at the vast number of ways and means by which a poultryman can detect the best layers of his flock. Indeed one exaggerates only slightly to say that there is scarcely an incident in the hen's daily program, nor an event in her life, that has not been interpreted by some unusually keen observer as a sign of producing ability—good or poor. Was the hen seen to rise early and dispatch a one-hundred-calory portion of mash, together with nine bugs and three worms, before her sisters were off the roost? Then put her down unqualifiedly as an industrious hen and enthusiastic layer—a credit to any poultry house. Was the hen observed to work after hours gleaning the last fragment of grain from the litter, or perchance chasing lightning bugs through the twilight grass, when other union-members of the flock had ceased work for the day and retired to roost? Then register her as one that has her master's interests at heart, and one that should be vigorously encouraged to reproduce her like. Did the hen lose the yellow glamour of her shanks and beak (doubtless the equivalent of good complexion in a hen)? Did she molt in July or August? Was her comb

[1] Contribution 250 from the Agricultural Experiment Station of the Rhode Island State College.

a ruddy red in September? Was her pelvis broad and flexible in April? Did she start laying in October? Did she lay thirty or more eggs before the first day of March? Did she lay 200 eggs in her pullet year, or 500 eggs in three years? Did she lay small eggs or large eggs? By all these signs one may (it is alleged) detect the hen that is (or has been) the good producer. But the curious part of the matter is that, notwithstanding these many signs and evidences of producing ability, the hens of the average poultryman continue to deliver the same number of eggs per year—estimated at about 120.

Among this variety of criteria, however, it must in fairness be said that some of the tests are of practical significance. It can scarcely be doubted that, as a rule, hens that lay the largest number of eggs during the "winter period" (November 1 to March 1), as first stated by Pearl, are the best layers for the entire year. On the other hand, it has been shown by Goodale that the production during the winter period may be strongly influenced by the time of hatching: the early-hatched hens make the highest winter records—at least they lay the greater number of eggs between the beginning of the laying period (sometimes as early as August) and March 1.[2]

If a hen is entitled to be called a good producer only on condition that she makes a creditable record for two or more years successively—then there is point to the recent contention of other investigators that hens that make a low first year's record usually "make up" during the second year, so that a three-year production record appears to them as representing the fairest measure of producing ability. This is of course the equivalent of saying that the number of eggs that a hen lays is a good criterion of her egg-producing ability—a circumstance which no one can deny. But it frequently happens that, for practical purposes, one desires such a criterion as will indi-

[2] It may be a question, however, whether the "winter period" of Goodale's early-hatched pullets may not in reality represent a combining of *two* laying cycles. His data on production seem to make possible this interpretation.

cate a hen's producing ability before she has attained that stage in life when economic production ceases; and when, even as a breeder, her further producing days are few.

II

To the casual reader it will no doubt appear preposterous that a biologist should attempt to measure the numerical egg-production of a hen by *weighing* her eggs, rather than by counting them. But the author freely admits that this ridiculous thing has actually been done in his laboratories; and, what is more, that the method appears to work: a flock of hens can be divided into groups, each characterized by a different mean producing ability, as a result of weighing a certain number of eggs at a certain time in the laying year, and subsequently by making certain computations therefrom. The results depend upon *the relation existing between egg-weight and egg-production at different periods of the laying year.* These points may be considered separately.

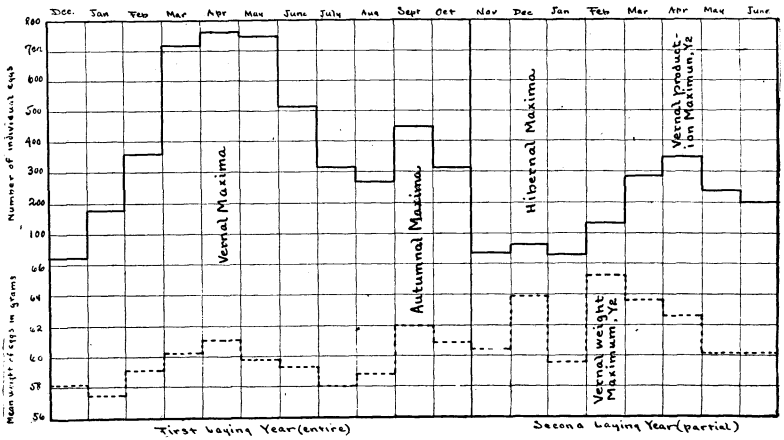

FIG. 1.

When the first yearly production of a flock of hens of equal age and condition is plotted on monthly ordinates one frequently obtains a curve such as indicated by the full line in Fig. 1. It is observed that the production

curve for the year ending October 31 is of the bimodal type.[3]

One of these modes, appearing on the spring of the year (in April), may be termed the *vernal production maximum.* The second mode, falling in September, may be called the *autumnal production maximum.* Of these two maxima for the first laying year the vernal maximum manifests the higher peak, in keeping with the heavy April production which is the highest of the year. Between any two successive maxima lies a fundus whose minimum is attained either in July or August, or in November of each year. The late summer depression may be termed the *æstival production minimum,* and the November depression, the *autumnal production minimum.* In the month of December of the second laying year it will be noted that the curve rises slightly. This represents the increased production of the "winter cycle" or, as it may be called, the *hibernal production maximum.* Between this and the vernal production maximum of the second laying year is another depression in the curve, following the period of winter production and indicating the *hibernal production minimum.* This is followed in turn by the vernal maximum of the second year.

The presence of these two maxima in the curve of production for the first laying year indicates that at least twice during this year (closing October 31), once in the spring and once in the autumn, the egg production of a hen rises from its lower limits and expresses itself by laying a larger number of eggs than at any other season. These periods of increased production represent the spring and the autumn cycles respectively. There exists also the winter cycle which is usually manifested with clearness only in those flocks which show a fairly high mean production. It is a significant productive period, but will not receive further consideration at this time. It may be added, however, that in birds that are fairly high producers and which are hatched sufficiently early

[3] These hens were poor winter producers and the expected mode for December-January of the pullet year does not appear.

in the year, the winter production maximum may make its appearance as the first cycle of production of the first laying year.

We have considered some of the more obvious variations in the curve of numerical production and come now to the curve of variations in egg-weight. Such variations may be considered with reference to the clutch, the litter, the cycle or the year.[4]

For present convenience, however, we shall consider the variation by months—purely arbitrary divisions in the life of the hen, which cut in on, and interrupt clutches, litters and cycles in such a way as frequently to obscure many of the problems involved. For our present purpose, however, division by months offers a rough and ready division of the year into short periods of time in which the productions may be compared.

When all the eggs laid by a flock of hens are weighed and recorded, and the monthly means computed and plotted on monthly ordinates, such a curve of mean monthly variation in egg-weight is obtained as that shown by the broken line in Fig. 1. Such a curve shows that all the eggs that a hen lays are by no means of equal weight. The first eggs laid are relatively small, but the weight increases gradually until a maximum weight for the first year is attained in the month of April. This is termed the *vernal weight maximum* and may represent mean increase of five grams over the mean weight of eggs for the first laying-month of the year. This maximum forms the first mode of the frequency curve of variation in egg weight as shown in the figure.

After April, the curve of variation in egg-weight drops for May, again for June, and reaches the lowest point in July, at which time the mean weight of the eggs of the flock may be scarcely greater than for the first month of production. Having struck this low point, however, the

[4] A *clutch* may be regarded as the group of eggs laid on successive days without an interruption. A *litter* is the group of eggs laid immediately preceding the onset of a broody period. A *cycle* is the larger group of eggs laid during any one of the seasonal periods of increased production.

mean egg-weight begins to rise again and reaches a second mode or maximum in September, at which peak the mean egg weight is slightly higher than for the period of the vernal maximum (April). This September peak may be called the *autumnal weight maximum.* The mean difference between the vernal maximum and the autumnal maximum is usually about one or two grams. Having attained this peak of weight, the curve drops again through October to strike its fundus in November (the first month of the second laying-year).[5] From this point it rises in December to the first weight maximum (*hibernal weight maximum*) of the second laying year, and then drops again in January to form the *hibernal weight minimum* immediately preceding the vernal maximum of the second year.

It will now be clear to the reader that there exists a noteworthy circumstance with reference to these curves of numerical production and of egg-weight: they parallel one another to a remarkable degree. The vernal maxima of production and of weight fall together in April; and the autumnal maxima of production and of weight fall together in September. The only departure from coincidence lies in the circumstance that the summer production minimum arrives in August, while the summer weight minimum is found in July. It should be said, however, that the plotting of the curves on ten or five-day ordinates might show a closer correspondence of these minima in point of time. The difference observed is scarcely significant. The definite agreements in the trends of the respective curves are taken to indicate that, on the average, increased production is accompanied by increased mean weight of the eggs produced; and that, *vice versa,* a decrease in production is, on the average, accompanied by decreased mean weight in the eggs produced. Whatever, therefore, may be the biological significance of the two production maxima for the hen's first

[5] It has become common to consider the laying year of a hen as extending from November 1 of the pullet year to and including October 31 of the year following.

laying year, the weight maxima would appear to possess a similar significance. Since the two are so closely correlated it would seem possible to measure a hen's innate egg-producing ability by the one phenomenon as well as by the other. This constitutes the hypothesis which we will now attempt to verify.

III

If we take a cross-section of the April production as nearly as possible to the absolute mode[6] of the weight curve, we learn that, although the egg-weight of most of the individuals of the flock has increased at this time, there are a few in which it has not increased significantly; and a still smaller number in which there has occurred a loss in egg-weight. The same is true for a cross-section of production taken at or near the absolute mode of the autumnal weight maximum. The following question therefore arises: *Does there exist any significant correlation between a tendency to manifest an increase in egg-weight at the period of the vernal weight maximum (or autumnal weight maximum) and the number of eggs produced for the entire first laying year (November 1 to October 31 following)?*

In order to demonstrate such a correlation one must first define more exactly the nature of the second variable, namely, the "tendency to manifest increased egg-weight" as referred to above. There must be a fixed point from which one can calculate, for each individual hen, the amount or the extent of increase in egg-weight manifested at the weight maxima. For certain reasons

[6] In explanation of this point it may be added that by plotting the frequency distribution of variation in April egg-weight on daily ordinates one may approximate more closely the absolute mode. This has been found to lie (for the flock in question) between April 11 and 15. For the autumnal weight maximum it lies between September 21 and 25. The absolute vernal production maximum lies between April 16 and 20, while the absolute autumnal production maximum appears between September 11 and 15. It is of course to be expected that these dates are only relative; that they would vary with different flocks, depending upon the climate, the date of hatching, the method of housing and presumably upon still other varying, environmental factors.

it was decided to compute all increase or decrease in egg-weight, for each individual, from the mean weight of the first ten eggs laid at the beginning of the first laying year of that particular bird. And, in order to translate the differences into comparable terms, the increase or decrease was calculated as a percentage increase or as a percentage decrease above or below the mean weight of those first ten eggs. Consequently, the percentage of increase or decrease in mean weight for all April eggs, over or under the mean weight of the first ten eggs laid, was ascertained in the case of each bird in the flock; and the same data were derived for the September production. It is upon the analysis of these raw data[7] that the appended computations rest. In the succeeding paragraphs it is therefore the aim of the writer to demonstrate the following point: that the higher percentages of increase in mean egg-weight, reckoned at the periods of the weight maxima, are so closely correlated with higher production for the first laying year, that, by the method to be presented, a flock of hens may be divided into groups characterized respectively by higher, medium and lower producing ability; and that this method is effective, whether the computations are based upon the vernal or the autumnal weight maxima.

IV

We may first concern ourselves with computations based upon the mean weight of the April eggs, including the eggs of the entire month; and it is scarcely necessary to resort to formal correlation tables to demonstrate the point involved. The simpler methods may be employed: (1) Dividing the birds on the basis of annual production above or below the flock-mean and then computing the percentage of net increase or decrease in mean egg-weight; (2) dividing the birds into groups based upon percentages of net increase or decrease in mean egg-

[7] It would be impossible to present these raw data in an article of this scope. They will be published, however, at the close of the investigation which is still in progress.

weight and then ascertaining the mean annual production for each percentage-group. To make the matter more clear both methods will now be applied—first to a differentiation of the flock on the basis of production groups.

For the purposes of the present inquiry the flock[8] may be divided into two groups on the basis of the mean annual production which was 120 eggs. One group was made up of individuals whose production was above the mean, and the other group included birds whose production was below. The mean production of the plus group was found to be 143 eggs, while the mean production of the minus group was 99. After these production-groups

TABLE I

SHOWING THE PRODUCTION OF THE FIRST LAYING YEAR OF GROUPS OF BIRDS SELECTED FOR DIFFERENT PERCENTAGES OF INCREASE OR DECREASE IN MEAN EGG WEIGHT, MEASURED AT THE PERIOD OF THE VERNAL (APRIL) WEIGHT MAXIMUM

PERCENTAGE-CLASS: Birds Selected for Increase in Egg Weight as Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year	PERCENTAGE-CLASS: Birds Selected for Increase in Egg Weight as Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year
> 10 per cent.	2	147	> 4 per cent.	17	132
> 9 " "	3	142	> 3 " "	21	122
> 8 " "	4	141	> 0 " "	31	122
> 7 " "	6	140	< 0 " "	6	111
> 6 " "	9	137	< 6 " "	28	112
> 5 " "	16	134	Total flock. . .	37[9]	120

had been established the mean net increase or decrease of egg-weight for each group was computed. The mean increase for the plus group was 5.4 per cent., and for the minus group 2.6 per cent. These results appear to indicate that, on the average, birds which manifest a greater percentage of increase in the weight of April eggs are likely to be the better producers of the flock.

In utilizing the second method mentioned above, the

[8] The flock in question consisted of 38 white Plymouth Rocks hatched in April, 1909. Some of the birds have now completed their seventh laying year.

[9] One hen, showing no increase and no decrease in mean egg-weight, and a production of 91 eggs, was omitted from the records.

birds of the original flock were divided into groups according to the percentage of net increase (or decrease) in the mean weight of eggs laid during the period of the vernal maximum (April). The percentage-groups were based on the scale indicated in the accompanying table.

From the data presented in Table I it is apparent that, on the average, the birds that showed the higher percentages of increase in the weight of the April eggs were also characterized by the higher productions. Those characterized by a weight-increase of 10 per cent. or more showed a mean production of 147 eggs, while those characterized by a weight-increase of more than 3 per cent. only, showed a mean production of only 122 eggs. The mean production of the group characterized by a *decrease* in egg-weight was the lowest of all—111 eggs, this being below the mean production of the entire flock.

If the birds are divided into two groups only, one having an increase of 6 per cent. or more, the other showing an increase of less than 6 per cent. or an actual decrease in egg-weight, it is found that the high-percentage group gives a mean production of 137 eggs, while the low-percentage group gives a production of only 112. In this instance the portion of the flock falling in the high-percentage class was approximately 24 per cent.; and this small group gave an average production that was 23 per cent. in excess of the production of the low-percentage group. The fact is thus brought out that, although a certain small proportion of high-producing individuals that are also characterized as manifesting only a slight percentage of increase in egg-weight at the period of the vernal weight maximum, will usually be found, the higher producers are, on the average, characterized by the larger percentages of increase (6 per cent. or above); and the selection of hens on this basis results in the separation of those individuals possessing the highest producing value.

V

In view of this correlation between numerical production and percentage of increase in egg-weight when measured at the period of the vernal maximum, it appeared desirable to ascertain whether a similar correlation existed between production and increase in egg-weight manifested at the *autumnal* (September) maximum. The same two demonstrational methods used in the previous instance may be applied.

The data on production were first re-distributed in such a manner as to group the percentages of increase or of decrease in egg-weight under two headings: (1) hens having an individual annual production greater than the mean (120 eggs), and (2) hens having an individual annual proportion of less than the mean production of the entire flock. In this way it was brought out that the plus group, with a mean production of 151 eggs, showed a mean net increase in egg-weight for September of 5.8 per cent., while the minus group with a mean production of 105 eggs showed a mean net increase of only one per cent.

TABLE II

SHOWING THE PRODUCTION OF THE FIRST LAYING YEAR OR GROUPS OF BIRDS SELECTED FOR DIFFERENT PERCENTAGES OF INCREASE OR DECREASE IN MEAN EGG-WEIGHT, MEASURED AT THE PERIOD OF THE AUTUMNAL (SEPTEMBER) WEIGHT MAXIMUM.

PERCENTAGE-CLASS Birds Selected for Increase in Weight Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year	PERCENTAGE-CLASS Birds Selected for Increase in Weight Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year
> 10 per cent.	8	143	> 4 per cent.	—	—
> 9 " "	9	141	> 3 " "	18	131
> 8 " "	10	140	> 0 " "	25	127
> 7 " "	11	142	< 0 " "	8	108
> 6 " "	12	141	< 6 " "	21	111
> 5 " "	14	137			
			Total flock...	33[10]	120

When the second method was applied, and the data redistributed so as to give the percentage-classes, the results shown in Table II were obtained.

[10] Four hens included in Table I were not employed in the present computations, because they failed to lay during September.

From the data presented in Table II it appears that, on the average, the birds that manifested the higher percentages of increase in the weight of the September eggs were characterized by higher annual production. Those showing a weight-increase of 10 per cent. or more gave a mean annual production of 143 eggs, while those birds characterized by a decrease in mean egg-weight showed an annual production of only 108 eggs. When the flock was divided into two groups according as the egg-weight had increased by more than 6 per cent. or less, the high-percentage group gave a production of 141 eggs as opposed to 111 eggs laid by the low-percentage group. Thus, dividing the flock on the basis of a 6 per cent. increase in the mean weight of all the September eggs, gave a group of 12 hens (out of 33) which showed a mean production 17.5 per cent. higher than the flock average (120), about 27 per cent. higher than the mean production of the low-percentage group, and 30 per cent. higher than the mean production of the small group of eight hens which manifested a decrease in mean egg-weight at the period considered.

It will hardly be necessary to call the attention of the reader to the circumstance that this method of demonstrating the correlation involved in the frequency distribution of these two variables (increase in egg-weight and numerical production) is, by its very nature, such as to constitute a practical application of the means involved.

The correlations between weight-increase and production, considered in the foregoing paragraphs, were so obvious that the question arose as to whether satisfactory correlations could not be demonstrated between these two variables under conditions in which a smaller amount of statistical data was employed. For instance, if the method should prove of value to poultrymen in affording a means for the detection of the higher producers of the flock, it would be desirable to reduce the machinery of computation to the lowest point consistent with valid results. It thus appeared pertinent to inquire whether computations based upon the weight of only ten eggs, laid as closely as possible to the periods of the absolute vernal

and autumnal maxima, respectively, would afford a satisfactory basis for establishing the weight-production correlations.

To this end, therefore, the mean weight of ten eggs laid by each member of the flock between the eleventh and twenty-fifth days of April[11] was computed, and the difference between the mean weight of these ten eggs and the mean weight of the first ten eggs laid by that hen at the beginning of her laying performance calculated as a percentage-increase or as a percentage-decrease. It should be added that the production during April was conducted at so rapid a rate that, in the case of 28 individuals out of 37, it was possible to obtain the record of ten eggs within the dates mentioned. In the remainder of individuals it was necessary to transcend these limits slightly. In no instance, however, was it necessary to take eggs from a date earlier than April 8, nor later than April 29. The data thus acquired were redistributed according to the percentage groups, and the results summarized in Table III.

TABLE III

SHOWING THE MEAN ANNUAL PRODUCTION FOR THE FIRST LAYING YEAR OF GROUPS OF INDIVIDUALS SELECTED FOR VARYING PERCENTAGES OF INCREASE OR DECREASE IN EGG-WEIGHT, COMPUTED ON THE BASIS OF THE WEIGHT OF TEN EGGS LAID AT THE PERIOD OF THE VERNAL WEIGHT MAXIMUM

PERCENTAGE-CLASS: Birds Selected for Increase in Weight Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year	PERCENTAGE-CLASS: Birds Selected for Increase in Weight Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year
> 10 per cent.	3	142	> 2 per cent.	27	123
> 8 " "	7	141	> 1 " "	29	122
> 7 " "	9	140	> 0 " "	31	120
> 6 " "	13	138	< 0 " "	16	106
> 5 " "	19	127	< 6 " "	24	114
> 4 " "	22	126			
> 3 " "	23	125	Total flock...	37	120

From the data presented in Table III it is clear that the small group of hens characterized by a percentage-increase on egg-weight of more than 10 gave a higher mean production (142 eggs) than any group manifesting a smaller percentage of increase in egg-weight. Each suc-

[11] See footnote on page 383.

ceeding group, characterized on a smaller percentage-increase, gave a correspondingly smaller annual production, until, when we reach "< 0 per cent.," the group manifesting a decrease in mean egg-weight, we find a mean annual production of only 106 eggs. When the flock is divided according as the mean percentage of increase is more than 6, or less than 6, we find that in the high-percentage group there are 13 hens with a mean annual production of 138 eggs, while in the low-percentage group there are 24 hens with a mean production of 114 eggs. In other words, upon the division point of 6 per cent. increase, one may separate about one third of the flock whose annual production is 15 per cent. higher than the flock average and 21 per cent. higher than the mean production of the remainder of the birds.

If the reader will now make a comparison of the results reported in Tables I and III, it will be seen that the correlation demonstrated through the employment of the "ten-egg method" is as clearly established, and as valuable from the practical point of view, as the correlation demonstrated through the use of a full month's production.

VII

In view, therefore, of these results obtained from the weighing of ten eggs at the period of the vernal weight maximum, it seemed desirable to ascertain whether the same "ten-egg method" at the period of the autumnal weight maximum would also serve to distinguish a group of hens characterized by the possession of higher producing ability. Accordingly the production data for September were analyzed from this point of view.

In explanation of the September results, however, several points should be noted. In the first place, although September production represents a definite mode in the annual production curve when plotted on monthly ordinates, in the case of the flock studied the month's production falls considerably short of the April production. In April all members of the flock, without an exception, were laying. In September there were four hens that did not lay at all; and three hens laid only three eggs or less.

In the redistribution of the data for the present purpose the records of no hens are included that did not lay at least five eggs in September. Two hens laid nine eggs five eggs. So that, in reality, the results of this case are based upon the mean weight of somewhat less than ten eggs from each hen.

In the second place it should be noted that the September production was scattered when compared with the April production; and although an attempt was made to secure eggs laid during the latter half of the month, it frequently happened that it was necessary to include eggs laid in the earlier part. The results of this redistribution of data and the attendant computations are presented in Table V.

TABLE IV

SHOWING THE MEAN ANNUAL PRODUCTION FOR THE FIRST LAYING YEAR OF GROUPS OF INDIVIDUALS SELECTED FOR VARYING PERCENTAGES OF INCREASE OR DECREASE IN MEAN EGG-WEIGHT, COMPUTED ON THE BASIS OF THE WEIGHT OF TEN EGGS OR LESS, LAID AT THE PERIOD OF THE AUTUMNAL WEIGHT MAXIMUM.

PERCENTAGE-CLASS: Birds Selected for Increase in Weight Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year	PERCENTAGE-CLASS: Birds Selected for Increase in Weight Indicated Below	Number of Individuals Making the Record	Mean Production for the First Laying Year
> 13 per cent.	3	147	> 2 per cent.	21	125
> 11 " "	6	145	> 1 " "	23	125
> 10 " "	7	143	> 0 " "	26	124
> 9 " "	8	144	< 0 " "	5	108
> 8 " "	10	144	< 6 " "	19	112
> 7 " "	12	139			
> 6 " "	12	139	September production 3 eggs or less..	7	96
> 5 " "	14	135	Ditto, plus hens showing decrease in wgt.	12	101
> 4 " "	16	134	Total flock.....	31	120
> 3 " "	19	131			

From the data presented in Table IV it appears, as in the former case, that higher production is correlated with the higher percentages of increase in egg-weight. The maximum group-production (147) occurred in those hens whose mean increase in weight was above 13 per cent. Selecting above 10 per cent. gave seven birds whose mean production was 143 eggs. Selecting above 6 per cent. gave twelve hens whose mean production was 139 eggs. On the other hand, selecting *below* 0 per cent. (*i. e.*, birds

showing a decrease in egg-weight) gave five hens with a mean production of only 108. When we add to these the hens that laid three eggs or less in September, we obtain a group whose mean production was only 96; and when we consider the hens that (1) gave a September production of 3 eggs or less, and (2) gave a decrease in egg weight, we obtain a combined group of 12 whose mean annual production was only 101 eggs for the first laying year.

A comparison of Tables I, II, III and IV thus shows that the last case presents the clearest evidence yet obtained for the positive correlation existing between percentage of increase in egg-weight and total annual production. The results are more definite than those obtained for the "ten-egg test" at the vernal weight maximum, or for the "month test" at either the vernal or the autumnal weight maxima. In other words a test based upon a smaller number of eggs, laid nearer to the absolute mode, gives a clearer indication of innate producing ability than does a test based upon a larger number of eggs laid in a "scatter grouping" about the approximate mode. This conclusion is in harmony with the views expressed by Gavin[12] and by Wilson[13] to the effect that the best unit of time for measuring a cow's milk-producing ability is not the year test, nor the thirty-day test, nor even the seven-day test, but the one-day test conducted when the production reaches its maximum. Apparently the measurement of egg-production in the domestic fowl, considered as a quantitative performance, rests upon a similar basis.

VIII

In bringing this paper to a close the writer wishes to have it distinctly understood that nowhere in these pages has it been stated that there exists in the domestic fowl a

[12] *Jour. Royal Agricultural Society,* 1913, 73. *Jour. Agricultural Society,* 1913, 5, 309–319. *Ibid.,* 1913, 5, 377–390 (on authority of Pearl).

[13] *Proc. Royal Dublin Society,* 1911, 13, 89–113. Jour. Dept. Agriculture, Ireland, 1913, 13, (4) (on authority of Pearl).

correlation between egg-production and egg-weight. Most poultrymen believe that, if a hen produces smaller eggs, she consequently produces more eggs; and, conversely, that if a hen produces larger eggs, she produces fewer eggs. This matter has not been considered in the present paper; it will be dealt with at a later time. The point may again be stated, that the significant correlation exists between numerical production and *the ability on the part of the hen to manifest an increase in egg-weight* at those seasons of the laying year when both production and egg-weight attain their respective maxima. A higher percentage of increase and absolute mean egg weight for the entire year has not yet been attempted. Many points like this remain to be worked out and the author does not wish to present his results dogmatically, but only with the hope that the problem will be attacked by other investigators. It is not improbable that the results may be found to vary with the breed of fowl, the date of hatching, the housing, the feeding and with other factors.

With these points openly in mind, and only with the purpose of stimulating further investigation and discussion, the author presents the following brief summary as expressing a biological fact which, if later proved to be of general application, may take its place as a fundamental law of production in the domestic fowl:

The innate egg-producing ability of a hen is manifested, not only by the number of eggs laid within a year, or within some shorter or longer period of time, but also by the degree of increase or decrease in the mean weight of her eggs, when this increase or decrease (calculated as a percentage-increase or as a percentage-decrease) is measured at those periods of laying (the vernal and autumnal maxima) characterized by the markedly increased production of the flock; and on this basis, groups of hens characterized by higher producing ability can be differentiated as accurately as, and more easily than by any other known means.